HEX-AXIS HORIZONTAL MOVEMENT DYNAMIC SIMULATOR

FIELD OF THE INVENTION

The invention relates to a hex-axis horizontal movement dynamic simulator, and more particularly to 6-degrees-of-freedom motion simulating equipment used in modular design.

BACKGROUND OF THE RELATED ART

An early structure of a 6-degrees-of-freedom motion simulating platform was proposed by the Englishman Steward, and is customarily called the Stewart Platform. For a long time, there was no significant improvement in the design of the Stewart Platform, which employed a hydraulic or pneumatic system to achieve the effect of changing the length of an actuating rod by varying the stroke of a cylinder rod to enable a 6-degrees-of-freedom spatial motion. Moreover, since the parts and components comprising the conventional Stewart Platform were not modular in design, and oil and air leakage problems occasionally occurred

with the hydraulic and pneumatic ~~system are always bother some~~ ~~that resulted in the inconvenience and disadvantage of replacing~~ ~~the parts and components in maintenance work.~~ ~~Therefore, the~~ ~~purpose~~systems, the Stewart Platform was inconvenient and required substantial maintenance.

SUMMARY OF THE INVENTION

A goal of the present invention is to provide a solution to the above-described problems of the conventional Stewart Platform ~~as mentioned above~~ by employing ~~the~~a modular design ~~as the core of~~ ~~the invention in stead~~instead of the hydraulic or pneumatic system ~~adopted~~used by the conventional Stewart Platform.—
~~SUMMARY OF THE PRESENT INVENTION~~ ~~The major purpose~~ Another goal of the present invention is to provide a hex-axis horizontal movement dynamic simulator ~~which~~that can simulate the motion of 6 degrees of freedom without employing a hydraulic or pneumatic system.——~~The minor purpose~~

A further goal of the invention is to provide a hex-axis horizontal movement dynamic simulator having a modular structure ~~which~~that comprises three modular movement control units of the same structure. The modular movement control units are located at ~~the~~ positions relative to each other forming three sides of an equilateral triangle and are pivoted to a load-carrying platform by ~~means of the~~a universal-joint yoke mechanism corresponding to

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each of the three movement control units ~~to construct simulation platform for simulating the motion of 6 degrees of freedom. Another purpose~~.

A further goal of the invention is to provide a specific structure of ~~the~~a modular movement control unit ~~which~~that can precisely control the movement of the load-carrying platform, and ~~enable~~provide a ~~structure of~~ motion simulation platform having 6 degrees of freedom.

BRIEF DESCRIPTION OF THE ~~DRAWING FIGURES~~ DRAWINGS

FIG. 1 ~~is the pictorial drawing showing the structure of the~~illustrates a first embodiment of the hex-axis horizontal movement dynamic simulator of the invention ~~which~~that has three sets of movement control units of the same structure located separately at the positions forming three sides of an equilateral triangle.

FIG. 2 ~~is the schematic drawing of~~illustrates the hex-axis horizontal movement dynamic simulator ~~shown in~~of FIG. 1 showing the variation of translation and angular motion of the load-carrying platform.

FIG. 3 is a schematic drawing of the invention shown in FIG. 2 as viewed from ~~other~~another direction.

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FIG. 4 is ~~the~~a disassembly drawing showing the parts of the movement control unit ~~shown~~illustrated in FIG. _1.— ~~FIG. 5 is the pictorial drawing showing the structure of the second type of~~

FIG. 5 illustrates a second embodiment of the hex-axis horizontal movement dynamic simulator ~~of the invention~~having three sets of movement control unit~~s~~ of the same structure located separately at the positions forming three sides of an equilateral triangle.—

FIG. 6 is ~~the~~a disassembly drawing showing parts of the movement control unit ~~shown~~illustrated in FIG. _5.—

FIG. 7 ~~is the pictorial drawing showing the structure of the~~illustrates a third type of embodiment of the hex-axis horizontal movement dynamic simulator ~~of the invention~~having three sets of movement control unit~~s~~ of the same structure located separately at the positions forming three sides of an equilateral triangle.—

FIG. 8 is ~~the~~a disassembly drawing showing the parts of the movement control unit ~~shown~~illustrated in FIG. _7.—

DETAILED DESCRIPTION OF THE ~~PREFERRED EMBODIMENTS~~ INVENTION

~~Now refer~~Referring now to FIG. 1 and FIG. 2, ~~the~~a key point of the ~~present~~ invention is that no ~~any~~ hydraulic or pneumatic system ~~being~~is used ~~by the~~in a hex-axis motion simulator ~~(10) is employed. One end of both~~10. For each universal-joint yoke

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mechanism 27, one end of each of two fixed-length connecting rods

~~(26) of fixed length~~ are pivoted to ~~a set of~~the universal-joint

yoke mechanism ~~(27),~~ and the other ends of the connecting rods

~~(26)~~ are separately connected to ~~the~~a transmission-joint yoke

mechanism ~~(25).~~ Further, ~~the said~~each transmission-joint yoke

mechanism ~~(25)~~ is pivoted to a ~~set of~~sliding seat ~~(24),~~ and the

rectilinear translation motion and position of ~~the~~each

transmission-joint yoke mechanism ~~(25)~~ is controlled by

controlling the rectilinear translation and position of the

corresponding sliding seat ~~(24) through which the connecting rod~~

~~(26) is actuated~~so as to generate a motion of 6 degrees of

freedom ~~which in turn~~that controls the spatial motion and position

of the load-carrying platform.—

The ~~h~~Hex-axis horizontal movement dynamic simulator ~~(10) as~~

~~depicted in the invention~~ comprises three movement control units

~~(20),~~ of the same structure ~~which,~~ that are fixed on ~~the~~a

foundation ~~(50)~~ at the locations relative to each other forming

three sides of an equilateral triangle. Each of the three

movement control units ~~(20)~~ is pivoted to the load carrying

platform ~~(60)~~ by ~~means of~~ a universal-joint yoke mechanism ~~(27).~~

Thus the locations at which the three ~~sets of~~universal-joint

yoke mechanism~~(~~s 27~~)~~ are pivoted to the load-carrying platform

~~(60)~~ form an equilateral triangle.—

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Each movement control unit (20) is symmetrically structured to comprise a universal-joint yoke mechanism (27), two connecting rods of fixed length (26), two transmission-joint yoke mechanisms (25), two sliding seats (24), two lead screws (23), two servo-driving mechanisms (22), and a rectilinear translation guide (21). Since universal-joint yoke mechanism (27) is pivotally connected to load-carrying platform (60), it can generate a motion of 1 degree of freedom relative to load-carrying platform (60). Since one end of each of the two connecting rods (26) is pivotally connected to the same universal-joint yoke mechanism (27), the connecting rod can generate a motion of 2 degrees of freedom.

Therefore, the end of the connecting rod pivoted to the universal-joint yoke mechanism (27) has 3 degrees of freedoms for generating a spatial motion relative to the load-carrying platform. Further, the other ends of the two connecting rods are symmetrically pivoted to separate driving joint yoke mechanisms (25) that can generate a spatial motion of 2 degrees of freedom. Since the transmission-joint yoke mechanism (25) of each connecting rod (26) is pivoted to a sliding seat (24), the transmission-joint yoke mechanism (25) has 1 degree of freedom for generating a spatial motion relative to the sliding seat (24). Therefore,

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the end ~~at which~~of the connecting rod {26} ~~is~~ pivoted to the transmission-joint yoke mechanism {25} has 3 degrees of freedom relative to the sliding seat {24} ~~in making a~~ for spatial motion ~~also.~~

Based on the above-mentioned arrangement, both ends of each connecting rod {26} of each movement control unit {20} ~~all~~ have 3 degrees of freedom for generating a spatial motion~~, and, because.__ Since all ~~the~~ connecting rods are fixed-length rigid ~~body of fixed length~~bodies, ~~therefore~~ when the sliding seat {24} ~~makes a rectilinear displacement~~ is displaced rectilinearly, the transmission-joint yoke mechanism {25} on one end of the connecting rod {26} is restricted to ~~do~~ rectilinear translation together with the sliding seat {24} ~~that,~~ which enables the connecting rod {26} to generate a spatial displacement of 6 degrees of freedom~~, and t.__ Through the variation of spatial position of every connecting rod {26}, the universal-joint yoke mechanism {27} on ~~another~~the other end of the connecting rod {26} will generate a relative spatial-displacement following the rectilinear displacement of the transmission-joint yoke mechanism {25}.

Therefore, when the sliding seat {24} makes a rectilinear translation to another place together with the transmission joint yoke mechanism {25} ~~its~~ to which it is pivoted ~~to~~, the spatial position of the connecting rod {26} on the transmission-joint

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yoke mechanism (25) associated with 6 degrees of freedom will

~~varied,~~vary. That ~~i.e.,~~s, the universal-joint yoke mechanism (27)

on one end of each connecting rod (26) will ~~changes~~ its spatial

position relative to the transmission-~~-~~joint yoke mechanism (25)~~,~~

and actuate the load-carrying platform (60) to ~~varying~~vary its

spatial position. ~~Refer to~~

Each of FIGs. ~~1 through FIG. 3, corresponding~~1-3 corresponds

to the rectilinear displacement of different sliding seats (24)

~~sliding,~~ which slide on different movement control units (20)

~~which~~ that are respectively located at the positions forming three

sides of an equilateral triangle~~, there will~~. The sliding seats

24 may have relative displacements ~~spatially generated by~~for the

load-carrying platform (60). ~~_~~ Therefore, through the synchronous

and precise control of the rectilinear movement of each sliding

seat (24) of each movement control unit (20), such as ~~the~~

~~synchronous control of the rectilinear movement of each sliding~~

~~seat (24) by~~may be provided by a computer system, the spatial

movement of each ~~set of~~universal-joint yoke mechanism (27)

relative to ~~each~~the others can be precisely controlled to achieve

a precise control of the motion of load-carrying platform (60) and

to generate linear and angular displacement spatially. ~~—~~

~~In the present invention t~~The mechanism ~~which~~that enables

each sliding seat (24) of each movement control unit (20) to

generate a rectilinear motion comprises two lead screws (23), two

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~~sets of~~ servo-driving mechanism~~(s~~ 22) ~~including~~ having

servo-motor~~(s~~ 221), a rectilinear translation guide (21)

~~including~~ having two guide seats (212) and two straight sliding

rail~~(s~~ 211). Each sliding seat (24) has a female screw thread

~~which~~that engages with the lead screw (23). The servo-motor (221)

of the servo-driving mechanism (22) is employed to drive the lead

screw (23) to rotate ~~that,~~ which enables the sliding seat (24) on

one of the guide seats (212) of the rectilinear translation guide

(21) to be guided by the straight sliding rail (211) and to

generate ~~a~~ rectilinear displacement. Therefore, the rectilinear

movement of each sliding seat (24) can be precisely controlled by

the precise control of the rotating speed and angular displacement

of the servo-motor (221) of each servo-driving mechanism (22),

through which a precise control of the variation of linear and

angular displacement of the load-carrying platform (60) can be

achieved.

The first ~~type of~~ embodiment of the movement control unit

(20) is shown in FIGs. 1 ~~through FIG. 4, which~~-4 and comprises ~~at~~

~~least~~ a base seat (40), a ~~set of~~ universal joint yoke mechanism

(27), two connecting rods of fixed length (26), two ~~sets of~~

transmission-joint yoke mechanism~~(s~~ 25), two ~~sets of~~ sliding seat

~~(s~~ 24), two lead screws (23), two ~~sets of~~ servo-driving mechanism

~~(s~~ 22), and a rectilinear translation guide (21). The base

seat (40) is a longitudinal plate fastened to the foundation (50)

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by bolt.＿ The rectilinear translation guide ~~(21)~~ has two linear sliding rails ~~(211)~~ parallel to each other and two identical guide seats ~~(212)~~.＿ The two linear sliding rails ~~(211)~~ are installed on the surface of the base seat ~~(40)~~ along the longitudinal direction of the base seat and parallel to each other, and the bottom side of each guide seat ~~(212) are~~ has two parallel guide slots ~~which~~ ~~are prepared to~~ that match the shape and gauge of the two straight sliding rails ~~(211)~~, ~~t.~~ Thus, each guide seat ~~(212)~~ can be installed on and match the two straight sliding rails ~~(211)~~, and slide on the two straight sliding rails along the guiding direction.—

Each servo-driving mechanism ~~(22)~~ comprises a servo-motor ~~(221)~~ assembled with a driving pulley ~~(222)~~, a driving belt ~~(223)~~, a driven pulley ~~(224)~~ and a bearing plate ~~(225) which~~ that drives a lead screw ~~(23)~~.＿ The bearing plate ~~(225)~~ of each servo-driving mechanism ~~(22) are~~ is installed ~~in~~at a position near ~~both~~a different ends of the base seat ~~(40)~~ so as to form ~~the~~a bracket for mounting the two lead screws ~~(23) by means of~~ with bearings and to have the two lead screws ~~(23)~~ parallel to the two straight sliding rails ~~(211)~~.＿ The driving pulley ~~(222)~~ is mounted on the driving shaft of the servo-motor ~~(221)~~, and the driven pulley ~~(224)~~ is mounted on the lead screw ~~(23)~~.＿ The driving pulley ~~(222)~~ and the driven pulley ~~(224)~~ are connected by the driving belt ~~(223)~~.—

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The sliding seat (24) is—in rectangular shaped and—is fastened to the guide seat (212) of the rectilinear translation guide (21). On the sliding seat (24), two penetrating holes (241), (242) are prepared—of which the h. Hole (241) has a female screw thread, and engages with the lead screw (23), another. The other hole (242) is a passage for another lead screw (23) to pass through. Further, on the tope surface of each sliding seat (24), is a mounting recess (243) for pivotally mounting the transmission joint yoke mechanism (25).—

The transmission-joint yoke mechanism (25) comprises a U-shaped yoke (251) and a T-shaped pivot axis. The horizontal stub shaft formed on both sides of the T-shaped pivot axis areis pivoted to the two vertical portions of the U-shaped yoke (251) by means ofa bearing and nut that enables the perpendicular stub shaft of the T-shaped pivot axis to have 1 degree of freedom of rotational motion relative to the U-shaped yoke (251). Besides, o On the bottom side of the U-shaped yoke (251), is a mounting shaft (253) which that is pivotally mounted to the mounting recess (243) by means ofa bearing and nut that enablesprovide the transmission joint yoke mechanism (25) to have with 1 degree of freedom of rotatingrotational motion relative to the sliding seat (24) it's pivoted to. Or t The perpendicular stub shaft of the T-shaped pivot axis (252) of each transmission-joint yoke mechanism (25) has 2 degrees of freedom of rotatingrotational motion

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relative to the sliding seat ~~(24) it's~~ <u>to which it is</u> mounted ~~to.~~

The universal-joint yoke mechanism ~~(27)~~ comprises an inversed U-<u>-</u>shaped yoke ~~(271)~~, a cardan shaft ~~(272)~~, a neck-ring seat ~~(274)~~<u>,</u> and a cover plate ~~(275)~~. <u>_</u> The left and right horizontal stub shaft<u>s</u> formed on both sides of the cardan shaft ~~(272)~~ are pivoted to the two vertical portions of the inversed U-<u>-</u>shaped yoke ~~(271)~~ by ~~means of~~<u>a</u> bearing and nut ~~etc.~~ that enables the perpendicular stub shaft formed on<u>_the</u> front and rear side of the cardan shaft (272) to have 1 degree of freedom of ~~rotating~~<u>rotational</u> motion relative to the inversed U-<u>-</u>shaped yoke ~~(271), moreover, o.~~ <u>On</u> the top side of the inversed U-<u>-</u>shaped yoke ~~(271)~~<u>,</u> is a mounting shaft ~~(273) which~~ <u>that</u> is pivoted to the neck-ring seat ~~(274)~~ by ~~means of~~ a bearing~~, and a.~~ <u>A</u> cover plate ~~(275)~~ is mounted on the upper side of the neck-ring seat ~~(274)~~<u>,</u> through which the whole assembly of the universal-joint yoke mechanism ~~(27)~~ is mounted on the load-carrying platform ~~(60), t.~~ <u>_</u> Thus<u>,</u> the inversed U-<u>-</u>shaped yoke ~~(271)~~ has 1 degree of freedom of ~~rotating~~<u>rotational</u> motion relative to the neck-ring seat ~~(274)~~ or the cover plate ~~(275) it is pivoted to, or t.~~ <u>The</u> perpendicular stub shaft on the front and rear side of the cardan shaft ~~(272)~~ of the inversed U-<u>-</u>shaped yoke ~~(271)~~ has 2 degrees of freedom of ~~rotating~~<u>rotational</u> motion relative to the neck-ring seat ~~(274)~~ or cover-plate ~~(275)~~. —

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Every connecting rod {26} has_a fixed length._ On both ends
of the connecting rod {26}_,_ are pivoting holes through which the
front end of the connecting rod is pivotally connected to the
front perpendicular stub shaft or rear perpendicular stub shaft of
the cardan shaft {272} of the universal-joint {27} ~~that enables~~._
Thus_, the pivoting hole on the front end of the connecting rod
{26} has 1 degree of freedom of ~~rotating~~rotational motion relative
to the perpendicular stub shaft of the cardan shaft {272} ~~it's~~
~~pivoted to, or, t~~._ The pivoting hole on the front end of every
connecting rod {26} has 3 degrees of freedom of ~~rotating~~rotational
motion relative to the neck-ring seat {274} or cover plate {275}~~,~~
~~Besides, t~~._ The pivoting hole on the rear end of every connecting
rod {26} is pivotally connected to the perpendicular stub shaft of
the T-_-shaped pivot axis {252} by ~~means of~~a bearing and nut that
~~enables~~provide the pivoting hole on the rear end of every
connecting rod {26} ~~to have~~with 1 degree of freedom of
~~rotating~~rotational motion relative to the perpendicular stub shaft
of the T-_-shaped pivot axis {252} ~~it's pivoted to, or, t~~._ The
pivoting hole on the rear end of every connecting rod {26} has 3
degrees of freedom of ~~rotating~~rotational motion relative to the
sliding seat {24} ~~it belongs to~~.—

Since each end of the connecting rod {26} has 3 degrees of
freedom of ~~rotating~~rotational motion, the whole connecting rod
{26} has 6 degrees of freedom for generating a spatial motion._

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The above-mentioned mechanism, as verified by the equation of mobility in Spatial Mechanism, ~~is proved to be above to~~ generates a spatial motion of 6 degrees of freedom ~~i.e.,~~ according to Gruebler~~+~~'s formula for a spatial mechanism:

$$F = 6(L - j - 1) + \sum_{i=1}^{j} f_i$$

$$L = 32, j = 36, \sum_{i=1}^{j} f_i = 36; F = 6$$

Where

—   F: Number of degrees of freedom of the whole mechanism—

      L: Total number of members in the mechanism—

      J: Total number of joints in the mechanism—

      f_i: The number of degree of freedom of the ith joint.—

Therefore, the relative rotating angle and rotating speed of the servo-motor ~~(221)~~ of the servo-driving mechanism ~~(22)~~ of each movement control unit ~~(20)~~, based on the required data or condition of the relative motion of the load-carrying platform ~~(60)~~ in space and by applying the precise calculation and control of the computer system (not shown in drawings), can be synchronously controlled~~, and t.~~ The sliding seat ~~(24)~~ and transmission-joint yoke mechanism ~~(25)~~ on each of the three movement control units can synchronously generate different

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rectilinear movement~~s~~ to drive the connecting rod~~(s 26)~~ to

generate relative spatial-displacement~~tos and~~ control the

relative spatial-movement of each universal-joint yoke mechanism

~~(27)~~, thus ~~enable~~enabling the load-carrying platform ~~(60)~~ to

~~generate different movement to attain the purpose of varying~~ vary

its~~of~~ posture and angular position ~~that can~~so as to simulate the

state of a carrier (such as vehicle, ship, airplane and roller

coaster etc.) ~~in~~ making a spatial motion of 6 degrees of freedom.—

In the following, is another embodiment of the movement

control unit ~~(20)~~ ~~which~~ that has the same mechanical structure

~~of~~and the same effect as that of the first ~~type~~ embodiment of the

~~movement~~ control unit ~~(20)~~ ~~as depicted in the above, and~~. This

second embodiment applies the same technical ~~means~~ and actuating

principle to enable the load-carrying platform ~~(60)~~ to simulate a

spatial motion of 6 degrees of freedom. ~~However, t~~ The

construction members and the inter-actuating relationship can be

obtained by reference to the detailed description of the first

~~type~~ embodiment mentioned above, which shall not be repeated here~~,~~

~~t~~. The following description ~~is only for~~describes the ~~structure~~

~~of other type of~~second embodiment of the movement control unit

~~(20)~~.—

The second~~type of~~ embodiment of the movement control unit

~~(20)~~ is shown in FIG~~s~~. 5 and ~~FIG.~~6 ~~which~~and comprises~~at least~~ a

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machine bed (41), one universal-joint yoke mechanism (27), two fixed-length connecting rods, two transmission-joint yoke mechanisms (25), two sliding seats (24), two lead screws (23), two servo-driving mechanisms (22), and a rectilinear translation guide (21). The components of the universal-joint yoke mechanism (27), the connecting rod (26), the transmission-joint yoke mechanism (25), the lead screw (23), the servo-driving mechanism (22), and the rectilinear translation guide (21) are the same as those in the first embodiment of the invention.

But, the machine bed (41) of the second embodiment of the invention is a rectangular stand made of a metal plate having an inversed U-shaped cross-section that is fastened on the foundation (50). A cover plate (411) is mounted on both the left and right ends of the machine bed (41) with holes and an opening prepared at appropriate positions. The servo-motor (221) of the servo-driving mechanism (22) is installed inside the machine bed (41). The driving shaft of the servo-motor (221) extends outside the machine bed (41). Through the opening of the cover plate (411) of the machine bed (41), a driving pulley (222) is mounted and fastened on the driving shaft of the driving-servo motor (221). Two support plates (227) of the servo-driving mechanism (22) are installed at places closed to

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both ends of the machine bed (41) to form the support for

pivotally mounting the two lead screws (23) by means of bearings

in a position parallel to the two straight sliding rails (211) of

the rectilinear translation guide (21). The driven pulley (224)

is mounted and fastened on the lead screw (23) with a transmission

belt installed on and passing through the driving pulley (222) and

driven pulley (224). Therefore, the driving power of the

servo-motor (221) is transmitted to the lead screw (23) through

the driving pulley (222), the transmission belt (223), and the

driven pulley (224).

The sliding seat (24) employed in the second type of

embodiment of the invention comprises at least a sliding block

(244) and a neck ring seat (246). The sliding block (244) is

fastened on the guide seat (212) of the rectilinear translation

guide mechanism (21). On the sliding block (244), two holes are

provided, one of which has a female screw thread, and engages with

a lead screw (23), another. The other hole serves as the passage

for another lead screw to pass through, t. The neck-ring seat

(246) is fastened on the tope side of the sliding block (244), or,

a fastening plate (245) shall be is installed on the top side of

the sliding block (244) at, first, and then fasten the neck-ring

(246) is fastened on the fastening plate (245). The mounting

shaft (253) of the U-shaped yoke (251) of the transmission-joint

yoke mechanism (25) is pivoted to the circular access on the tope

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side of the neck-ring seat ~~(246)~~ by ~~means of~~a bearing and related parts.—

~~What shall be mentioned here is that t~~The sliding seat ~~(24)~~ employed in the second ~~type of~~ embodiment and ~~the same in~~ the first embodiment can be exchanged and used in either of the two ~~types of~~ embodiment~~,~~s or in other embodiments of the invention.—

The third ~~type of~~ embodiment of the movement control unit ~~(20)~~ is shown in FIGs. 7 and ~~FIG.~~ 8 ~~which compresses at least~~and comprises a base seat ~~(40)~~, a ~~set of~~ universal-joint yoke mechanism ~~(29)~~, two fixed-length connecting rods ~~(26)~~ ~~of fixed length~~, two ~~sets of~~ sliding yoke mechanism~~(~~s 28~~)~~, two leading screws ~~(23)~~, two ~~sets of~~ servo-driving mechanism~~(~~s 22~~)~~, and a rectilinear translation guide ~~(21)~~ ~~wherein the said~~. The connecting rod ~~(26)~~, lead screw ~~(23)~~, servo-driving mechanism ~~(22)~~, and rectilinear translation guide ~~(21)~~ are the same as those employed in the first ~~type of~~ embodiment~~, and t~~. The structure of the universal-joint yoke mechanism ~~(29)~~ is similar to the sliding yoke mechanism ~~(28)~~.—

The universal-joint yoke mechanism ~~(29)~~ of the ~~aforesaid~~ third embodiment comprises an inversed U-~~-~~shaped yoke assembly ~~(291)~~, a pivoting plate ~~(293)~~, a pivoting shaft ~~(295)~~, two fixing blocks ~~(296)~~, an L-~~-~~shaped yoke plate ~~(297)~~, a fastening yoke plate ~~(298)~~, and two cover plates ~~(299)~~. The L-~~-~~shaped yoke plate is formed by a horizontal portion and a vertical portion. The

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horizontal portion is fastened on the load-carrying platform (60), and on the. A vertical portion hole is provided for mounting a shaft. The fastening yoke plate (298) is a plate-shaped member with appropriate thickness having an appearance symmetric to that of the vertical portion of the L-shaped yoke plate (297). S A shaft mounting hole is also provided on the fastening yoke plate (298), which is to be assembled with the L-shaped yoke plate (297) to form a yoke assembly. The pivoting plate (293) is in rectangular shape with a pivoting access in its center position and horizontal stub shafts (294) extended symmetrically from both sides opposite to each other which are that pivotally mounted in the hole on the L-shaped yoke plate (297) and the fastening yoke plate (298) by means of bearings and related parts, t. The two cover plates are fastened on one side of the vertical portion of the L-shaped yoke plate (297) and the fastening yoke plate (298) to fix the whole assembly that enables and provide the pivoting plate (293) to have with 1 degree of freedom of rotating rotational motion relative to the L-shaped yoke plate (297) and the fastening yoke plate (298) its fastened to;. The yoke assembly (291) has a mounting shaft (292) extended upwardly from its top side and is mounted in the pivoting access in the center position of the pivoting plate (293) by means of a bearing, and a cover is fastened on the mounting surface of the pivoting plate to fix the assembly. Therefore, the yoke assembly has 1 degree of freedom of

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~~rotating~~rotational motion relative to the pivoting plate 293 ~~its pivoted to, or~~and has 2 degrees of freedom of motion relative to the L~~—~~-shaped yoke plate ~~(297)~~ and the fastening yoke plate ~~(298)~~~~,~~. The bottom side of the two flanks of the yoke assembly ~~(291)~~ has_a semicircular recess, and the fixing block ~~(296)~~ also has_a corresponding semicircular recess on the_top side. _A shaft ~~(295)~~ is pivotally installed by fixing the two fixing blocks on the bottom side of the two flanks of the yoke assembly ~~(291)~~, and both ends of the pivoting shaft ~~(295)~~ can be pivotally connected to the connecting rod ~~(26)~~ ~~that enables~~so as to provide the pivot hole on the front end of each connecting rod ~~has~~with 1 degree of freedom of ~~rotating~~rotational motion relative to the yoke assembly ~~(291)~~ ~~it's pivoted to, or, has~~and 3 degrees of freedom of ~~rotating~~rotational motion relative to the L~~—~~-shaped yoke plate ~~(297)~~ and the fastening yoke plate ~~(298)~~.——

The sliding yoke mechanism ~~(28)~~ employed in the third embodiment comprises a U~~—~~-shaped yoke assembly ~~(281)~~, a pivoting plate ~~(283)~~, a shaft ~~(285)~~, two fixing blocks ~~(286)~~, a_n L~~—~~-shaped sliding yoke plate ~~(287)~~, a sliding fastening plate ~~(288)~~, and two cover plates ~~(289)~~. The ~~said~~ L~~—~~-shaped sliding yoke plate ~~(287)~~ has a horizontal portion and a vertical portion~~,~~ and is fastened on the guide seat ~~(212)~~ of the rectilinear translation guide ~~(21)~~ through its horizontal portion. ~~Besides, t~~The L~~—~~-shaped sliding yoke plate ~~(287)~~ has two penetrating holes, one of which has_a

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female screw thread, and engages with the lead screw (23),

~~another~~. The other hole serves as a passage for another lead

screw (23) to pass through. In addition, the vertical portion of

the L-shaped sliding yoke plate (287) has a pivoting hole. The

sliding fastening plate (288) is a plate-shaped member ~~with~~of

appropriate thickness ~~having~~and has an appearance symmetric to

that of the vertical portion of the L-shaped sliding yoke plate.

Two penetrating holes and a pivoting hole are provided on the

sliding fastening plate (288) ~~of which t~~. The two penetrating

holes are for the two lead screws (23) to pass through. A yoke

assembly is formed by assembling the sliding fastening plate (288)

and the L-shaped sliding yoke plate (287). The pivoting plate

(283) is ~~in~~ rectangular shaped with a pivoting access in a center

position and horizontal stub shafts (284) extended symmetrically

from both sides opposite to each other ~~which are~~that pivotally

mounted in the hole on the L-shaped sliding yoke plate (287) and

the sliding fastening yoke plate (288) by ~~means of~~a bearing and

related parts~~, and then t~~. Two cover plates are fastened on one

side of the vertical portion of the L-shaped sliding yoke plate

(287) and the sliding fastening plate (288) to fix the whole

assembly so that ~~enables~~ the pivoting plate (283) has 1 degree of

freedom of ~~rotating~~rotational motion relative to the L-shaped

sliding yoke plate (287) and the sliding fastening plate (288)

~~it's pivoted to~~. The yoke assembly (281) has a mounting shaft

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{282} extended downwardly from its bottom side ~~which~~that is
pivotally mounted in the pivoting access in the center position of
the pivoting plate {283} by ~~means of~~a bearing and ~~the~~ related
parts~~, and a~~. A cover is fastened on the pivoting plate {283} to
fix the assembly~~, therefore~~. Thus, the U-~~-~~shaped yoke assembly
{281} has 1 degree of freedom of ~~rotating~~rotational motion
relative to the pivoting plate {283}~~, or~~ and has 2 degrees of
freedom of ~~rotating~~rotational motion relative to the L-~~-~~shaped
sliding yoke plate {287} and the sliding fastening plate {288}.
The top~~e~~ side of the two vertical portions of the U-~~-~~shaped yoke
assembly has a semicircular recess, and ~~the~~a corresponding
semicircular recess is ~~also~~ provided on the fixing block {286} on
the bottom side. A shaft {285} is pivotally installed by fixing
the two fixing blocks {286} on the top side of the U-~~-~~shaped yoke
assembly, and both ends of the pivoting shaft {285} can be
pivotally connected to the connecting rod {26} ~~that enables~~so as
to provide the pivot hole on the rear end of the connecting rod
{26} ~~has~~with 1 degree of freedom of ~~rotating~~rotational motion
relative to the U-~~-~~shaped yoke assembly {281}~~, or has~~ and 3
degrees of freedom of ~~rotating~~rotational motion relative to the L
-shaped sliding yoke plate {287} and the sliding fastening plate
{288}. Since ~~either of the two~~both ends of the connecting rod
{26} has~~ve~~ 3 degrees of freedom of ~~rotating~~rotational motion, each

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connecting rod ~~(26)~~ ~~shall~~ have~~s~~ 6 degrees of freedom of

~~rotating~~<u>rotational</u> motion in space.